

THE GENERATION OF CUSPS ON GRAVEL BEACHES: THE EVALUATION OF EDGE WAVE AND SELF-ORGANIZATION HYPOTHESES

Douglas J. Sherman
Department of Geography
University of Southern California
Los Angeles, CA 90089-0255
phone: (213) 740-0061 Fax: (213) 740-0056 e-mail: sherman@usc.edu
Award#: N000149710810

LONG-TERM GOALS

My long term goal is to contribute to our understanding of fluid-sediment interaction in coastal environments. Of particular interest to me are the topographical expressions of nearshore flow characteristics, especially the development of bedforms and beach cusps. I am also interested in understanding the dynamics of coastal aeolian systems.

OBJECTIVES

The primary objective of this project is to obtain the requisite hydrodynamic and morphologic measurements to distinguish between a system self-organization or an edge wave origin for beach cusps. The experiment was designed to measure waves and currents in the surf zone immediately adjacent to a gravel beach foreshore, to measure the morphological evolution of that foreshore, and to measure swash and slope characteristics. The resulting data should allow for an unambiguous test of the competing hypotheses.

APPROACH

Seven flow meters and eleven pressure transducers, forming 3 alongshore and 2 cross-shore transects, were deployed on the nearshore sea bed to capture wave and current data. Swash hydrodynamics and excursion dimensions were monitored by a video camera and related parameters will be obtained by video image analysis. The gravel foreshore was graded into a planar configuration and subsequent cusp development was monitored. Beach topographical changes were surveyed by an engineering level and an EDM. Foreshore pebbles were sampled. Through analysis of hydrodynamic data, longshore periodicity of the wave run up, offshore structure and the phase relationship of the orbital velocities of horizontal currents components and water surface elevations are obtained.

WORK COMPLETED

The field experiment was carried out on Slievebane Beach at Malin Head, Ireland in June 3 - 19, 1997. Preliminary examination of the resulting data indicates that the experiment was a success.

The sensors and the data acquisition system worked well. Hydrodynamic data and video image data during active formation of beach cusps from the graded plane beach were obtained. Reliable beach topographies were surveyed. Hydrodynamic data are calibrated and preliminary analysis of hydrodynamic data (e.g., spectral analysis) has been nearly finished. Beach topographies have been mapped. Sediment size and shape analysis is complete. Video image analysis just started.

RESULTS

Fully-developed beach cusps were formed during the two high tide period on June 19 when a medium storm wave and the Spring tide coincided. The first-set cusps (three cusps in the monitoring area with spacing of 7.4 m, 8.4 m, and 7.0 m) were formed from the plane gravel foreshore during the morning high tide. The second-set cusps developed again on the regraded beach during the evening high tide period. The slope of the graded foreshore ranged from 0.15 to 0.20.

The average horizontal excursion distance of run up (from breaking point to the swash front) was 6.2 m and the significance distance (the highest 1/3) was 9.5 m. The incident wave period was 12 seconds, which shows a sharp peak in the spectra for u , v , and η . The next peak in v and η spectra is at about 40 seconds. The phase between u and v is near $\pi/2$, u and η is -0.7π (or 0.3π), and u and η is also -0.7π (or 0.3π) for the 12-second incident waves.

We are still at stage of reconstructing the wave fields from the hydrodynamic data. Preliminary results suggest that no single edge wave form will match the cusp spacing according to the standing edge wave model.

IMPACT/APPLICATIONS

It is too soon to project the applications of the results of this experiment.

RELATED PROJECTS

During the experimental deployment, several sets of data were obtained from a shore normal instrument array. These data will be used to evaluate characteristics of wave shoaling and breaking on a near-planar slope.

REFERENCES

No publications have resulted from this experiment. Stay tuned!